

## ***Chikyu* Okinawa Drilling Expedition: “Hydrothermal Sediments in Okinawa Trough(HOT)” (Expedition Report)**

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The Japan Agency for Marine-Earth Science Technology (JAMSTEC: Asahiko Taira, President) carried out scientific drilling research in the Okinawa Trough. It forms part of “Scientific Research on Genesis of Marine Resources” (led by Katsuhiko Suzuki, Group Leader, Resource Generation Environment Research Group, Research and Development Center for Submarine Resources, JAMSTEC) for “Next-generation Marine Resources Survey Technologies” (Program Director: Tetsuro Urabe, Professor Emeritus, Graduate School of Science, the University of Tokyo; Advisor, Japan Mining Engineering & Training Center) in the Cross-ministerial Strategic Innovation Promotion Program (SIP<sup>\*1</sup>).

### 1. Overview

The aim of this expedition was to figure out distribution of the sub sea-floor hydrothermal fluid reservoirs in the Iheya North Field as the first step for building a scientific theory of genesis of inactive deposits and concealed mineral deposits (buried seafloor). The Deep Sea Drilling Vessel (D/V) *Chikyu* drilled six sites with logging while drilling (LWD<sup>\*2</sup>) across the Iheya North Knoll including the sub sea-floor hydrothermal fluid reservoir found by the IODP<sup>\*3</sup> expedition in 2010 (as reported on October 5, 2010) and newly discovered hydrothermal fields between 2012 and 2013 (as reported on March 4, 2014). As a result, data on distribution of the sub sea-floor hydrothermal fields in the Iheya North Field and physical properties were obtained ([figure 1](#)).

This scientific research was led by Dr. Ken Takai (Principal Scientist, Submarine Hydrothermal System Research Group, Research and Development (R&D) Center for Submarine Resources, JAMSTEC). Other members on board were mainly from Institute of Advanced Industrial Science and Technology, National Institute for Environmental Studies, and Research and Development (R&D) Center for Submarine Resources at JAMSTEC participating in the above mentioned “Next-generation Marine Resources Survey Technologies” program.

### 2. Results

(1) Distribution of the sub sea-floor hydrothermal fluids beneath the Iheya North Knoll ([figure 2](#))

Iheya North Knoll is a volcanic complex with 8km in diameter at the base. This research expedition indicated that three hydrothermal sites (Iheya North Original, Iheya North Natsu, and Iheya North Aki: [figure 1](#)) may be derived from one large hydrothermal fluid reservoir across the Iheya North Knoll. It is considered to be one of the largest hydrothermal fields found around Okinawa. Based on comparison of

the seismic reflection survey data and this LWD data, and also geological core samples, the scale of hydrothermal fluid reservoir at the Iheya North Original is estimated to be stretched more than 2km from east to west and 3km from south to north.

(2) Collection of the detailed LWD data and samples of mineral deposits (accumulation of minerals)

LWD data was obtained at six sites as shown in the figure 1 with asterisks. It demonstrated that LWD is an effective tool for accurate estimation of cap rocks (a non-permeable geological formation, which prevents fluids from migration up from below), distribution of hydrothermal alteration zones and also hydrothermal fluid flow paths. Moreover, we could confirm the distribution of the sub sea-floor hydrothermal fluid reservoirs and hydrothermal alteration zones by comparing the data obtained with LWD and core samples from drilled holes. Core samples of layers of sulfide minerals, which is presumed to be a source of the sub sea-floor hydrothermal fields based on the LWD data (figure 3), were also successfully collected. These findings suggest that a LWD tool, which has been used for oil industry, can be a new tool for investigating sea-floor hydrothermal deposits.

(3) Preliminary collection of environmental baseline data near and at drilling sites

In the neighboring of drill sites, Remotely Operated Vehicle (ROV) on D/V *Chikyu* sent out an unmanned probe to record and monitor the area, collect samples and measure temperature with its censor. For analysis of surface environments, the surface sea water was also collected, and phytoplankton was cultivated and identified on the vessel.

### 3. Future Schedule

Under the "Next-generation Marine Resources Survey Technologies" for SIP, we will investigate the large-scale hydrothermal distribution beneath the Iheya North Knoll through a detailed analysis of the core samples and physical properties. We will also install long-term monitoring equipment at drill holes to observe the in-situ formation process of the hydrothermal mineral deposits. Further, we will develop and establish an effective screening method to identify potential areas by utilizing the aforementioned findings coupled with well-established exploration methods. A specific achievement report will be released as a research paper.

### 4. Schedule of *Chikyu*

After changing the crew members and unloading equipment at Nakagusuku Port, Okinawa on July 26, the *Chikyu* will move to Shimizu Port, Shizuoka for maintenance.

#### \*1 Cross-ministerial Strategic Innovation Promotion Group (SIP)

It is a newly established program for scientific technology innovation. The Council for Science, Technology and Innovation (CSTI) leads management across government ministries and existing fields. 10 issues including "next-generation ocean resources research technology" have been selected for the program.

#### \*2 Logging While Drilling (LWD)

It is a technology with which a variety of physical properties is measured near the

drill bit at the bottom of the drill string. The data acquired is transmitted to the vessel in real time.

\*3 Integrated Ocean Drilling Program: IODP

The Integrated Ocean Drilling Program (IODP) is a multinational cooperative project carried out from 2003 to 2013 at the initiatives of Japan and the U.S. The scientific drilling vessels D/V *Chikyu* operated by Japan and the JOIDES Resolution by the U.S, and the option to charter mission-specific platforms by Europe were utilized for expeditions. The research aimed to shed light on global environmental changes, the earth's mantle and crust dynamics and tectonics, and the biosphere beneath the seafloor. Beginning in October 2013, it was taken over to the International Ocean Discovery Program (IODP).

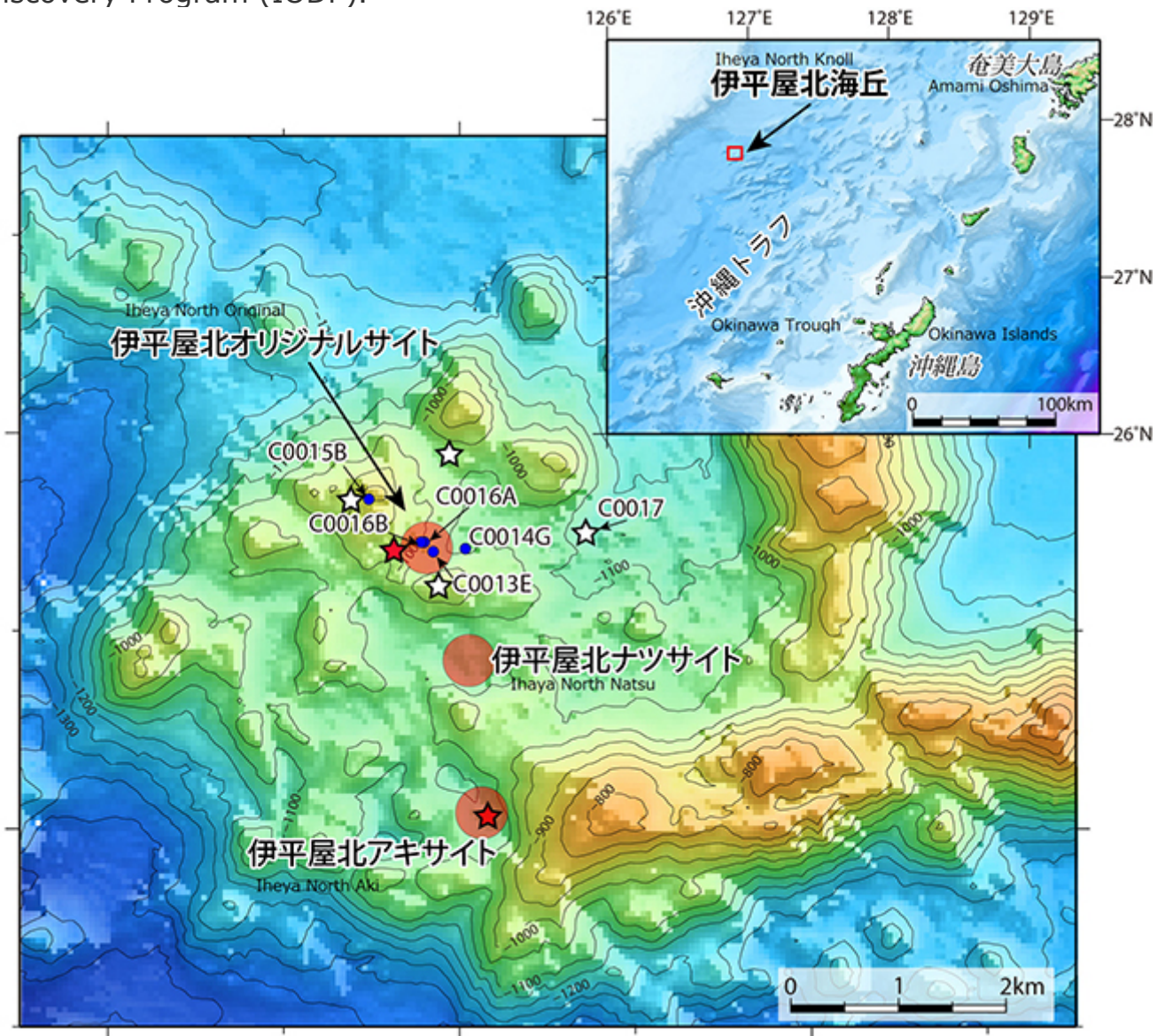


Figure 1: Drilling sites

- ★ : LWD and core sampling sites
- ☆ : LWD sites
- : IODP scientific drilling sites (C0013E, C0014G, C0015B, C0016A, C0016B, C0017)

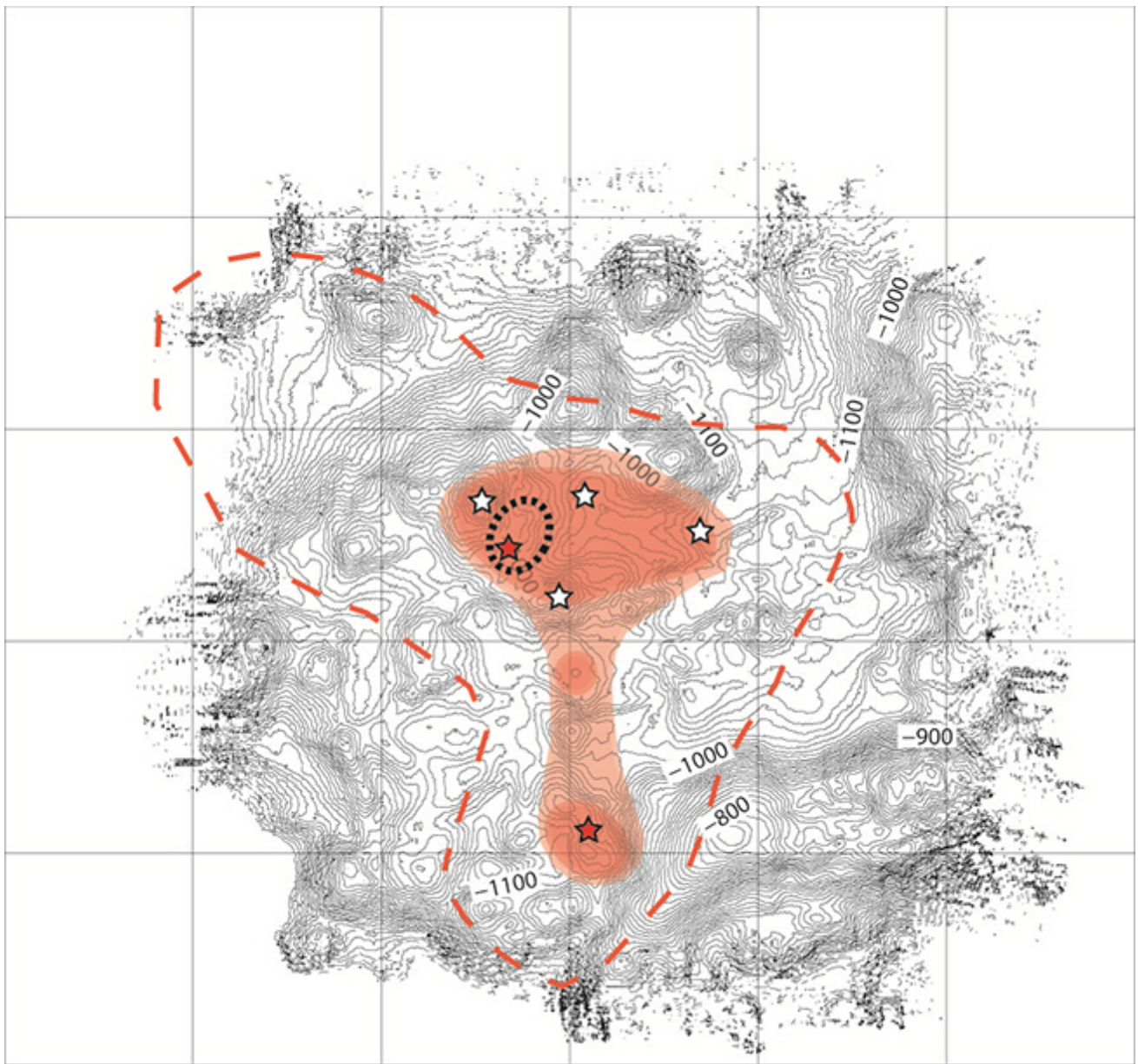


Figure 2: Presumed distribution of hydrothermal fluid reservoir (Bathymetric map of the figure 1 and the neighboring area)

Dashed black line: Iheya North Original Site

Dark red: Area where existence of hydrothermal fluid is confirmed based on the LWD data or seafloor observation

Light red: Area where hydrothermal fluid reservoirs are presumed to exist based on the LWD data and seismic reflection imageries

Dashed red line: Potential area inferred from seismic reflection survey

★ : LWD and core sampling sites

☆ : LWD sites

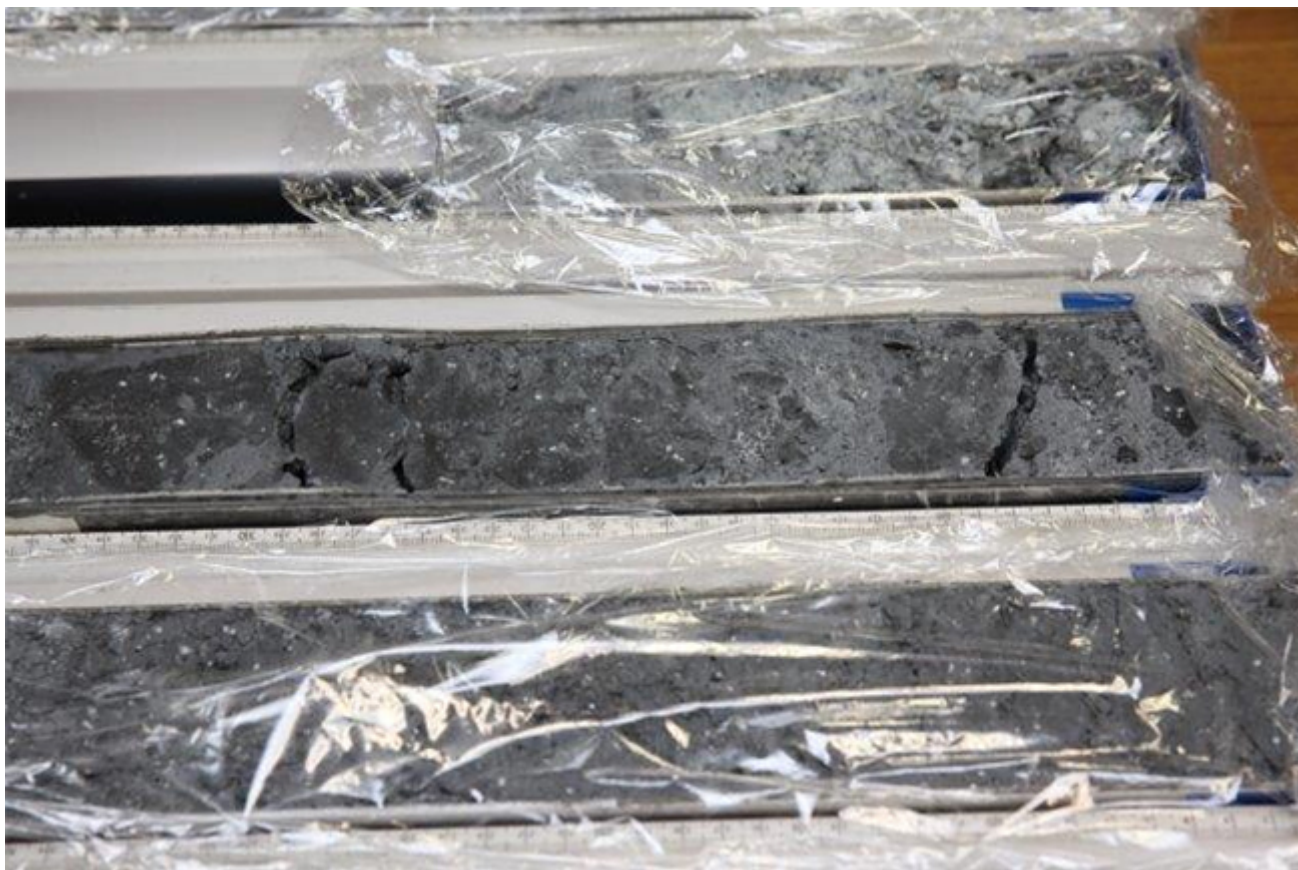


Figure 3: Typical core sections that contain massive sulfide blocks

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